Notebook Series -- Notebooks by Experimenters Other Than Edison
Battery Experiments -- J. A. Hanley Books
Notebook, N-19-08-27

This notebook was used by John A. Hanley during August-September 1919 for notes on experiments, many involving nickel-treated paper, with various batteries and battery components. Included is information on discharge rate and efficiency of experimental cells. Some of these experiments, which were carried out under Edison's supervision, may have been related to work on the auto starter and Ford generator. The front cover is labeled "Storage Battery Experiments. Aug. 27/19. to - Sept 26/19 Book No.1. J. Hanley." The pages are unnumbered. Approximately 115 pages have been used.

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Edison Lab.
West Orange
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73498

Acme Co.,
MFG. STATIONERS,
96 JOHN ST.
AND
19 PLATT ST.
NEW YORK.

Aug 27/19.

Put No. 58 on charge for 1 hour at 100 ma.

Discharged 100 ma for 9 min.
Efficiency about 14%

No 151 on charge for 1 hour 100 ma.

Discharge at 100 ma.
This remained at 100 ma for 70 minutes.

Found that the copper and zinc gives over 150 ma.

The deposit scaled and fell off, exposing the bare copper.

No good

Tried others but found that deposit fell off on all of them.

Aug. 28/19.

Connected a volt meter across the terminals of cell.

The current and voltage of a bare nickel element 1½ square immersed in pottash solution with zinc is 70 MA, 40 MV.

Nickel plated iron the same size is 200 MA, 40 MV.

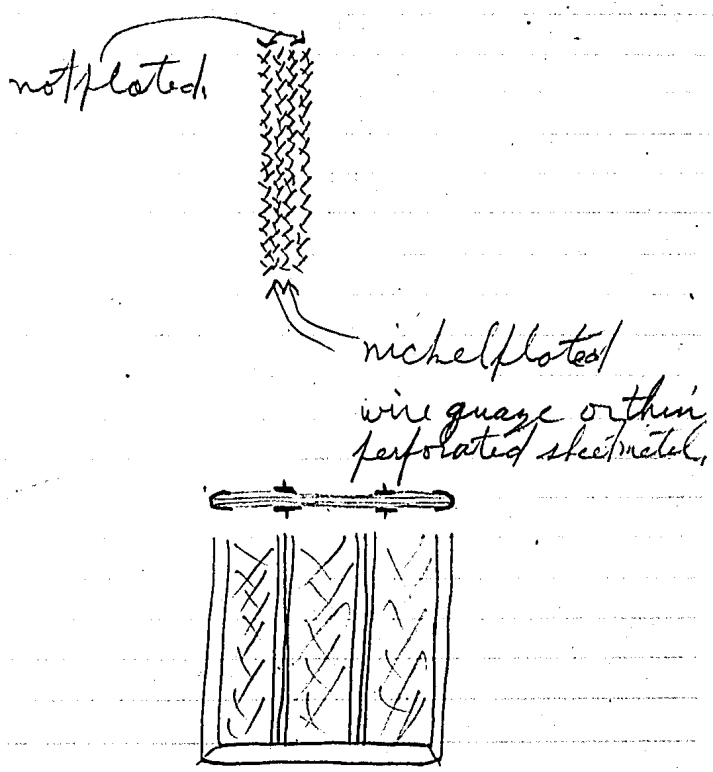
Bare iron is 100 MA, 20 MV.

(20% pottash solution)

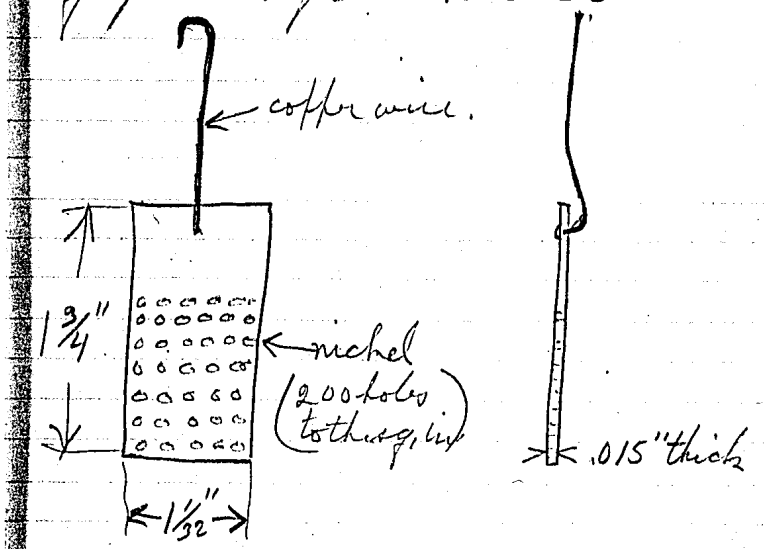
Put a nickel plated element treated by Mr. Edison on charge for 2 hours at 25 MA.

Deposit starts falling off after being in solution for 15 min.

No discharge No good
iron is exposed.

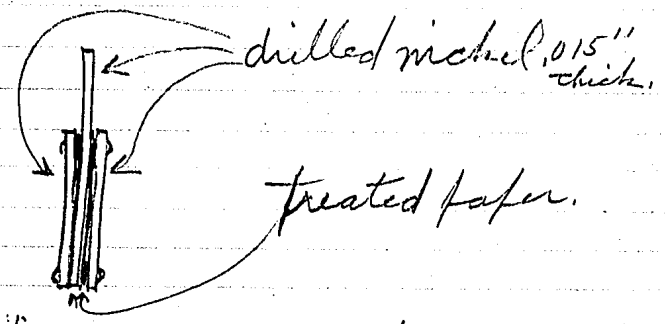


Burns is making up a number of pieces from nickel.



Aug. 29/19.

Made up the following.



Laid a piece of paper treated by Mr. Edison on each side of a piece of the drilled nickel and then riveted a piece of the same nickel on each side.

Charge 100 MA 2 hours.

Discharge 100 MA 7 min.

Efficiency about 6%

Repeat charge 100 ma, 1 hour

Discharge 50 ma 2 min.

Efficiency 1 2/3 %

Paper is not clamped tight enough. (poor contact)

Put treated paper between two pieces of perforated nickel plated metal (as used for iron pockets in Edison battery) clamped both pieces together by overlapping 1/32" of the edge of one all around the other.

The nickel hydrate was dry when put between the above mentioned pieces.

Charge 100 ma 1 hour

Discharge 100 ma 3 min.

Efficiency 5 %

Repeat Charge, 100 mA 1 hour
Discharge 50 mA 4 min.
Efficiency 3 1/3 %
Poor contact with the above
Not clamped tight enough.

Aug. 30/19

Mr. Edison put a nickel coil wrapped with treated paper and bound with thread, on charge overnight at about a 50 MA rate.

Charge	50 MA	15 hours
Discharge	50 MA	26 min.
Efficiency	3%	

Charge	400 MA	1 min.
Discharge	50 MA	8 min.
Efficiency	100%	

Charge	1 Amp.	1 min.
Discharge	50 MA.	8 min.
Efficiency	40%	

Charge 1 amp. 1 min.
Discharge 50 ma 7 min.
Efficiency 39%

Charge 400 ma 1 min.
Discharge 50 ma 7 min.
Efficiency 87%

Charge 400 ma 1 min.
Discharge 50 ma 6 min.
Efficiency 75%

Charge 1 amp. 1 min.
Discharge 50 ma 6 min.
Efficiency 33%

This affair is very inconsistent.
Seems to be poor contact,
Contact also seems to be variable.
Some hydrate fell out from paper while charging.

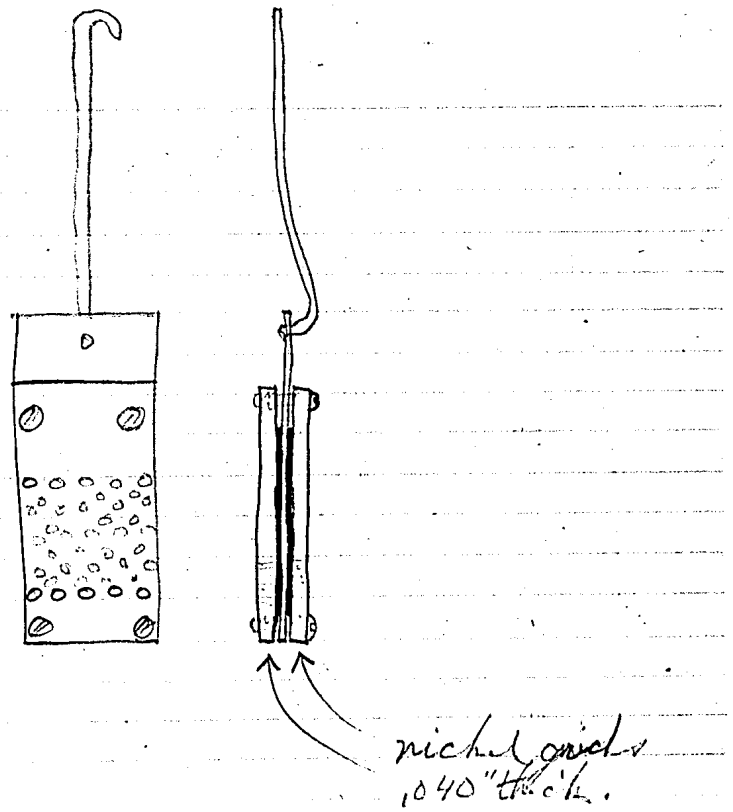
Made a paste from powdered $Ni(OH)_2$ mixed with a 20% potash solution ($NaOH$)

Put some of this paste between two pieces of nickel plated metal (perforated) and clamped together.

Charge 400ma, 1 min.

Discharge 50ma 1 min.

Efficiency. 12.5%



Charge 1 Amp 1 min.

Discharge 50 ma 1 min.

Efficiency 10%

Made of a paste of $Ni(OH)_2$ with a little 20% potash solution and rolled on one side of a piece of yellow pad paper.

Placed on each side of a nickel grid and clamped together with screws, using a heavier grid on each side.

Charge 100 ma 1 hour

Discharge 50 ma 10 min.

Efficiency 8 1/3 %

Charge 400 ma 1 min.
Discharge 50 ma 4 min.
Efficiency 50%

Charge 1 amp. 1 min.
Discharge 50 ma 6' 30"
Efficiency 33%

Charge 1 amp. 1 min.
Discharge 50 ma. 5' 30"
Efficiency about 30%

Sept 2/19

Nickel grid wrapped with treated paper.
bound with thread.

Charge	100 ma	60 min.
Dis.	50 "	7 "
Eff.		6%
	200 ma	1 min
	50 "	4 "
Eff.		100%
	400 ma	1 min.
	50 "	7 "
Eff.		87%
	800 ma.	1 min
	50 "	4 "
Eff.		25%

Sept. 2, 19.

Copper plate waffed with treated paper.

100 MA. 60 min
50 " 14 "

Eff. 119%

Nickel plate waffed with treated paper.

100 MA 60 min.
50 " 24 "

Eff. 209%

The above plates had about two sq. in surface.

Sept. 2/19.

Paper treated on one side clamped between nickel guides.

100 ma		60 min.	
50 "		48 "	
Eff	40%		
200 ma		1 min	
50 "		3' 30"	
	87%		
400 ma.		1 min	
50 "		5' 30"	
	70%		
800 ma.		1 min	
50 "		8 "	
	50%		
1000 ma		1 min	
50 "		9 "	
	45%		
100 ma		60 min	
50 "		54 "	
	45%		

200 ma 1 min.
50 " " "
275%

800 ma 1 min.
50 " 8' 30"
53%

1000 ma 1 min.
50 " 9 "
45%

Treated linnen clamped to one side of a perforated nickel grid.

Charge 100 MA. 60 min.

Nothing on discharge.

Sept. 3/19.

Drilled nickel grid filled with paste $Ni(OH)_2$
Linnen on each side.
sewed on tight.

Charge 100 MA 60 min.
Nothing on discharge.

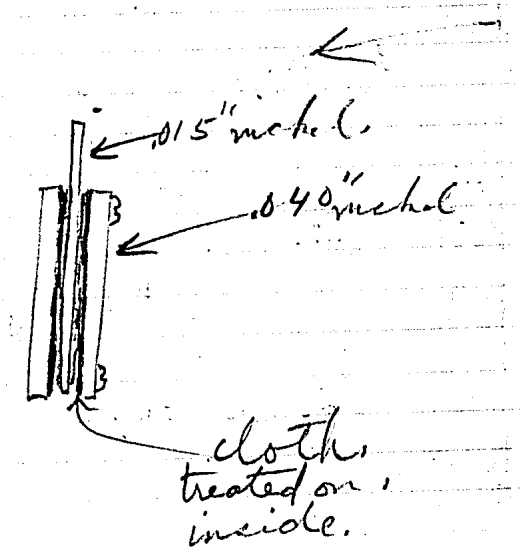
Treated linnen rivetted between two pieces of thin perforated nickel.

Charge 100 MA. 60 min.
Nothing on discharge.

Perforated nickel wrapped with three turns of treated linnen.

Charge 100 MA 60 min.
Dis. 50 " 2 "
Eff. 1/3 %

CSJ



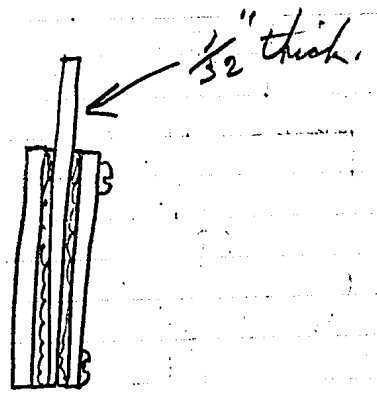
No. 1.

Sept. 3/19.

Linen, treated on one side.
Clamped between three nickel grids)

Charge 50 ma		16 hrs.
Dis. 50 "		58 min.
Eff		6 %
Charge 100 ma		60 min.
Dis 50 "		40 "
Eff	33 1/3 %	
Charge 400 ma		1 min.
Dis 50 "		7 "
Eff	86 %	
Charge 1000 ma		1 min.
Dis. 50 "		8 "
Eff.	40 %	
Charge 500 ma		1 min.
Dis. 50 "		7 "
Eff.	71 %	
Charge 100 ma		60 min.
Dis. 50 "		45 "

Eff 40 %

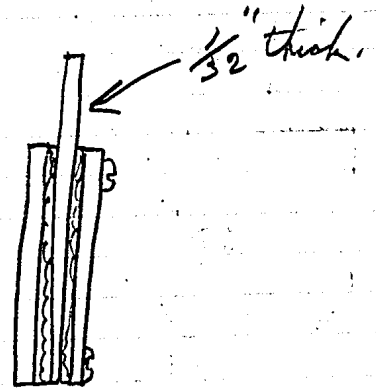


No 2.

Sept 3/19.

Liming treated clamped to nickel grid 1/32" thick.

Charge 50 MA.		16 hrs.
Dis.	50 "	64 min.
Eff		6 2/3 %
Charge 100 MA		60 min.
Dis.	50 "	48 "
Eff.		40 %
Charge 400 MA		1 min.
Dis	50 "	6 "
Eff		75 %
Charge 1000 MA		1 min.
Dis.	50 "	7 "
Eff		33 %
Charge 500 MA		1 min.
Dis	50 "	6 "
Eff		62 1/2 %



No 2.

Sept 3/19.

Sinning treated clamped to nickel grid 1/32" thick.

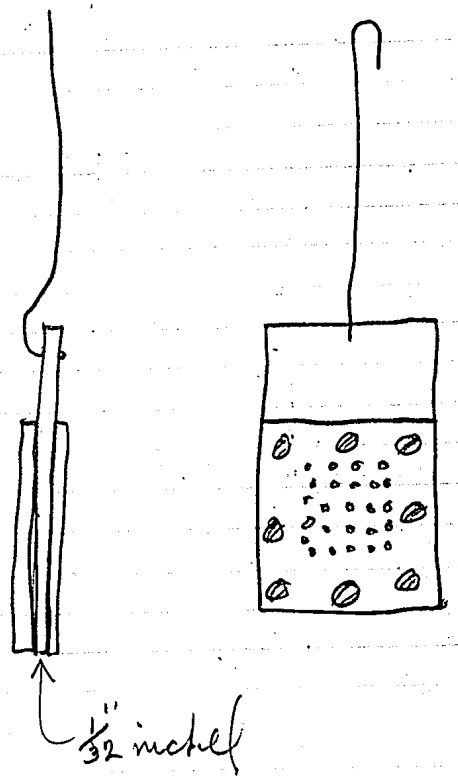
Charge 50 MA. 16 hrs.
Dis 50 " 64 min.
Eff 6 2/3 %

Charge 100 MA 60 min.
Dis. 50 " 48 "
Eff. 40 %

Charge 400 MA 1 min.
Dis 50 " 6 "
Eff 75 %

Charge 1000 MA 1 min.
Dis. 50 " 7 "
Eff 33 %

Charge 500 MA 1 min.
Dis 50 " 6 "
Eff 62 1/2 %



Sept. 6/19.

$Ni(OH)_2$ mistened with a little NaOH, pressed in a drilled nickel grid 1/32" thick under hydraulic pressure. (1000 lbs.)

Filter paper on each side clamped with grids of monel metal 1/16" thick about one sq. in. area.

Formed for 20 hrs at 50 MA.
Discharged 50 MA 24 min.

Input. 60000 M.A.M.
Output. 1200 "

Charge " 50 M.A. 60 min.
Dis. 50 " 18 "

Input 3000 M.A.M.
Output. 900 "
Eff 32%

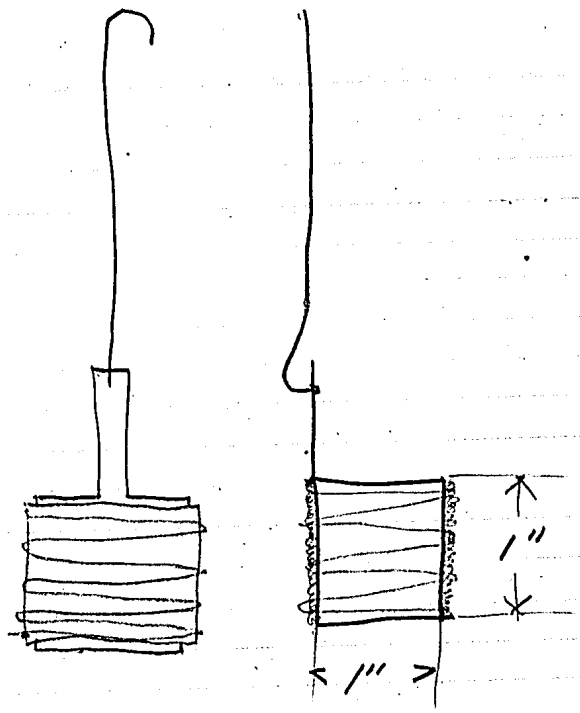
Time	Voltage
10:16	1.84
10:20	1.75
10:25	1.66

10:30	1.62
10:31	1.6
10:32	1.58
10:33	1.44
10:34	1 Volt.

Charge 100 ma. 120 min.
Dis 50 " 22'30"

Input 12000. m.a.m.
Output. 1125 "
~~Eff 9%~~

Time	Voltage.
2:39	1.8
2:45	1.72
2:50	1.7
2:55	1.66
3	1.6
3:1	1.52
3:1'30"	1 Volt.



Sept 6/19.

Cylinder of .007" electrickel 1" in diameter.

blotting paper treated with $Ni(OH)_2$ paste, wrapped around same ~~cloth~~ and bound with string.

Area about 3 sq. in.

Formed about 14 hours at 50 ma.

Dis. 50 MA 40 min.

Input. 42000 M.A.M.
Output. 2000 "

~~Eff~~

Time	Voltage.
9:12	1.9
9:45	1.72
9:55	1.69
9:57	1 Volt.

Voltage fell rapidly from 1.64

Charge	50 ma	60 min.
Dis.	50 "	35 "

Input. 3000 mam
Output. 1750 "
Eff 59%

11:	1.92
11: 5	1.82
11: 10	1.79
11: 15	1.77
11: 20	1.75
11: 25	1.74
11: 30	1.72
11: 35	1.66
11: 35' 10"	1 Volt.

Charge 100 mA 120 Min.
Dis. 50 " 51 "

Input. 12000 mAm
Output. 2550 "
Eff. 25 %

1:40	1.92
1:50	1.76
2:	1.76
2:10	1.745
2:20	1.73
2:25	1.705
2:30	1.685
2:31	1 Volt.

Sept 6/19.

Data on Epide lead batteries used on Ford automobiles for starting and lighting:

Capacity 80 Amp-hours.

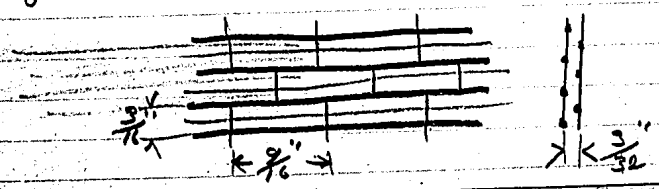
Voltage per cell on full charge (open circuit) 2.15.
Drop on 150 Amp discharge .7 V.
Pos. and Neg. plates constructed the same. (grids $\frac{3}{16}$" X $\frac{9}{16}$" X $\frac{3}{32}$")

6 pos. plates } to each cell.
7 neg. " }

Outside measurement of plates 5" high, 5 $\frac{3}{4}$" long, $\frac{3}{32}$" thick.

Outside measurement of grid area. 4 $\frac{5}{8}$" high 5 $\frac{3}{4}$" wide.

Grid construction like this.



Total area of active material exposed on positive plates is 303.72 sq in.

Area of negative plates is 354.34 sq in.

Plates of one cell assembled is 5" high 5 3/4" long. 2 3/8" wide, weight is 9 1/2 lbs. wood spacers included in this weight.

Measurements of container of each cell (outside) is 2 5/8" wide, 6" long, 7 7/8" high 9/32" wall.

Cheap rubber construction.

Outside measurement of battery (complete for use) overall 9 1/4" long, 7 9/16" wide. box height is 8 1/8" overall height 9"

Weight (complete)

41 lbs.

Cu. in. of space occupied by Epidi. 629.5 Cu. in.

Amp. hours per cu. in. .128 A.H.
" " " lb. 1.95 A.H.

Sept. 8/19.

Repeat tests on clamped nickel grid. as used Sept. 6.

Charge	50 ma	120 min.
Dis	50 "	20 "

Input. 6000 mam
Output. 1.000 "
Eff 16 2/3 %

Time	Voltage
11:56	1.8
12:5	1.7
12:10	1.68
12:15	1.62
12:16	1 Volt.

Charge.	100 ma	5 min.
Dis.	50 "	7 "

Input. 500 m.a.m.
Output. 350 "

2:29	1.84
2:35	1.74
2:36	1 Volt.

Eff 70 %

Charge	100 mA	5 min.
Dis.	50 "	7 "
2:44		1.84
2:45		1.8
2:46		1.78
2:47		1.77
2:48		1.75
2:49		1.73
2:50		1.71
2:51		1 Volt.

Input. 500 mam
Output. 350 "
Eff 70 %

Charge	100 mA	5 min.
Dis.	50 "	7 "
2:58		1.84
2:59		1.8
3:		1.78
3:1		1.77
3:2		1.74
3:3		1.73
3:4		1.72
3:5		1.71
3:5'10"		1 Volt.

Input. 500 mam
Output. 350 "
Eff 70%

Charge.	100 ma	5 min.
Dis.	50 "	8 "

2:23	1.84
2:24	1.81
2:25	1.79
2:26	1.77
2:27	1.76
2:28	
2:29	
2:30	1.71
2:31	1.68
2:31'2"	1 Volt.

Input. 500 mam
Output. 350 "
Eff. 80%

Charge	100 ma	25 Min.
Dis.	100 "	6 "

5:40	1.76
5:45	1.5
5:46.	1 Volt.

Input: 2500 mam.
Output. 600 "
~~Eff. 24%~~

The capacity of this affair seems to be 1000 mam
The area is aproximately 1 sq. in.

Ampere minute capacity is 1

Ampere hour capacity is 1/60 th.

Average efficiency percentage on charges lower than 1000 mamp. is 72½%

Sept 8/19

Continue tests on round nickel and blotting paper affair as used Sept. 6

Charge	50 ma	120 Min
Dis.	50 "	54 "

Time	Voltage
11:1	1.92
11:5	1.84
11:15	1.8
11:25	1.77
11:35	1.76
11:45	1.73
11:50	1.71
11:51	1.71
11:52	1.7
11:53	1.7
11:54	1.69
11:55	1.64
11:55'5"	1 Volt.

Input	6000 mam.
Output.	2700 "

Charge	100 mA	20 min.
Dis	50 "	39 "

1:40	1.9
1:45	1.83
1:55	1.78
2:5	1.75
2:15	1.71
2:16	1.7
2:17	1.69
2:18	1.68
2:19	1 Volt.

Input. 2000 mam
Output. 1950 "
Eff. 98%

Charge	100 mA	5 min.
Dis.	50 "	6½ min.

3:39'30"	1.82
3:42	1.77
3:44	1.74
3:46	1 Volt.

Input. 500 mam
Output. 325 " Eff. 65%

Charge. 100 MA 5 min.
Dis. 50 " 9 "

3:56	1.84
3:57	1.81
3:58	1.79
4	1.77
4:2	1.75
4:4	1.64
4:5	1 Volt.

Input. 500 m.am.
Out. " 450 "
Eff 90%

Charge 100 ma. 5 min.
Dis. 50 " 8 "

4:14	1.84
4:16	1.78
4:18	1.75
4:20	1.72
4:21	1.67
4:22	1 Volt.

Input. 500 mam
Out. 400 " Eff. 80%

Charge	100 ma.	10 min.
Dis.	50 "	17 "
	4:35	1.86
	4:45	1.75
	4:50	1.69
	4:51	1.56
	4:52	1 Volt.

Input. 1000 mam
Out. 850 "
Eff 85%

Charge	100 ma	25 min.
Dis.	100 "	15'30"
	5:21	1.85
	5:25	1.79
	5:30	1.75
	5:35	1.69
	5:36	1.58
	5:36'30"	1 Volt.

Input. 2500 mam.
Output. 1550 "
Eff 62½%

The area of this affair is approximately 3 sq. in.

The capacity seems to be around 2500 m.a.m.

In one case it showed as high as 2700.

The variation is due to the poor contact.

Average percent on charges under the capacity: 80%

Higest % is 98

Sept 10/19.

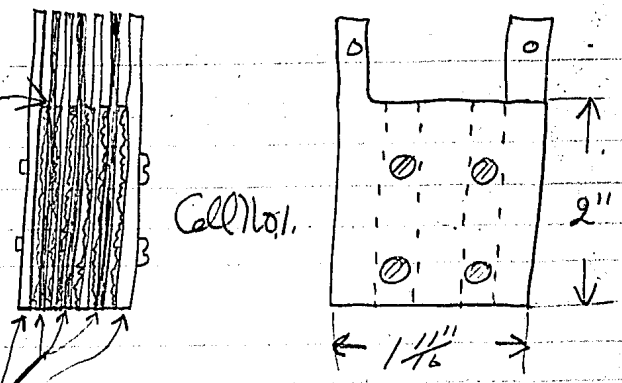
Round nickel strip.
$Ni(OH)_2$ put on by electrolysis by Mr. Edison.

Formed, 50 MA, 6 hrs.
Discharge, 50 " 2 min.

This is no good.
On taking paper off cylinder found $Ni(OH)_2$ to be well formed.

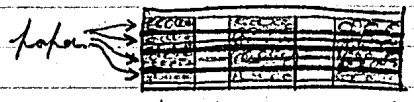
Could not see any reason for it not working.

It would be a slow and expensive method and could not compare with ~~the~~ other methods.



heavy nickel clamping plates .040" thick.
3 zinc plates .020" thick.
blotting paper strips 2" long by 3/8" wide, treated on the side facing the nickel plates with $Ni(OH)_2$ ground to about 200 mesh, put on in the form of a paste.

Cell No. 2 is the same except the blotting paper is the full size of plates (2" X 1 1/16") instead of being put in, in strips.



bottom view of Cell No. 1.

Sept 10/19.

Formed the two cells shown on opposite page at 25 ma. 14 hrs.

Cell No. 1.

Discharged 50 ma. 150 min.

11	1.88
11:10	1.805
11:30	1.775
11:50	1.76
12:10	1.75
12:30	1.74
12:50	1.73
1:10	1.715
1:20	1.705
1:25	1.7
1:29	1.675
1:30	1.66
1:30'20"	1 volt.

Input. 21000 mam
Output. 7500 " Capacity.

Area 13.5 sq. in.
5.64 mill amperes per sq. in.

.094 Ampere hours per sq. in.

Charge	50 ma	120 min.
Dis.	50 "	7 min 40 sec.

Open circuit voltage	1.87
4:30	1.84
4:31	1.83
4:35	1.805
4:55	1.77
5:15	1.74
5:35	1.71
5:40	1.69
5:41	1.68
5:41' 30"	1.64
5:41' 40"	1 Volt.

Input. 6000 m.a.m.
Out. 3583 "
Eff. 60%

Cell No. 2.

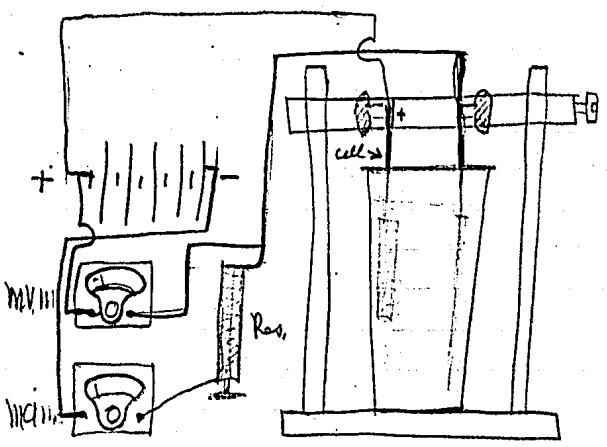
Formed same as No 1.
This cell has 19 sq. in. area.

Discharged 50 ma. 85 min 10 sec.

9:32'30"	1.9
9:35	1.84
9:40	1.81
10	1.76
10:20	1.74
10:40	1.72
10:50	1.7
10:55	1.675
10:56	1.66
10:57	1.64
10:57'30"	1.6
10:57'40"	1 Volt.

Input. 21000 mam
Out. 4258 "

Milliamperes per sq. in. is 2.24
10.0.37 Ampere hours per sq. in.



Sept. 11/19.

Put Nos. 1 and 2 on charge at 25 MA. using the nickel and zinc as positive and negative respectively.

On at 9 a.m.

Left for ship (Hanoli) at 10 a.m.

Will be gone for a few days.

Sept. 15.

Returned to lab.

To continue battery experiments and testing.

Sept. 16.

Cells No. 1 and 2 were in the solution from Sept. 11.

Charging battery feel down.

Cells discharged for only a few minutes.

The paper seems to be in good condition to all appearances.

Recharged Cell No 1. 100 MA. 30 min.
Dis. " 50 " 38½"

11:12	1.9 Volts.
11:15	1.85
11:25	1.815
11:35	1.79
11:45	1.76
11:50	1.73
11:50'30"	1 Volt.

Input. 3000 m.a.m.
Output. 1925 "

66 2/3 %

Repeat charge 100 ma 30 min.
Dis " 50 " 44½ "

1:15	1.89
1:20	1.84
1:30	1.815
1:40	1.8
1:50	1.77
1:59	1.7
1:59' 10"	1 Volt.

Input 3000 m.a.m.
Output 2208 "

Eff. 77 %

Repeat charge	100 ma.	90 min.
Dis "	50 "	49½ min.

3:6	1.9
3:7	1.88
3:10	1.85
3:20	1.825
3:30	1.8
3:40	1.78
3:50	1.75
3:55	1.71
3:55' 30"	1 Volt.

Input. 3000 m.a.m.

Output. 2475 "

Eff 82.6 %

Repeat charge 100 ma. 30 min.
Dis. " 50 " 47 "

5:4	1.9
5:10	1.85
5:20	1.82
5:35	1.78
5:40	1.765
5:45	1.75
5:50	1.72
5:51	1 Volt

Input. 3000 m.a.m.

Output. 2350 m.a.m.

Eff. 78½%

Sept. 16.

Charge Cell No. 2. 100 mA. 30 min.
Dis. " 50 " 9'30"

11:1	1.9
11:5	1.79
11:10	1.71
11:10'30"	1 Volt.

Input 3000 mA.m.
Output 475 " 16%.

Repeat charge 100 mA 30 min.
Dis. " 50 " 13 "

12:58	1.85
1	1.8
1:5	1.76
1:8	1.74
1:10	1.71
1:11	1 Volt.

Input 3000 mA.m.
Output. 650 "

21%

Repeat charge		100 MA	30 min.
Dis.	"	50 "	24½ "

2:40	1.9
2:42	1.86
2:46	1.82
2:50	1.79
2:55	1.775
3	1.75
3:3	1.71
3:4' 30"	1 Volt.

Input. 3000 M.A.M.

Output. 1225 "

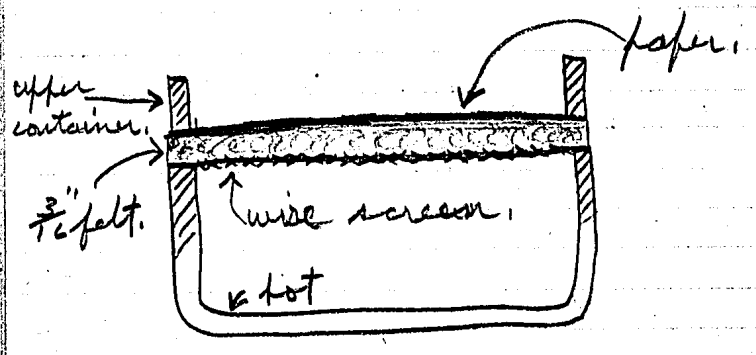
Eff 40%

Repeat charge 100 ma. 30 min.
Dis " 50 " 30 "

4:30	1.93
4:31	1.89
4:32	1.87
4:35	1.835
4:40	1.805
4:50	1.76
4:55	1.74
4:59	1.7
5	1 Volt.

Input. 3000 m.a.m.
Output. 1500 "

Eff 50%



section of filter apparatus

Use distilled water.

Sept. 16.

Put some (Rawlstone) paper .004" thick in 20% NaOH at 12 a.m.

This is to allow NaOH to eat out impurities and prepare paper for further use.

Sept. 17

Removed paper from NaOH after leaving in for about 18 hours.

Washed out.

NaOH showed discoloration, showing that something was eaten out.

Deposited 2 grams of $Ni(OH)_2$ on 12 sq. in. of this paper.

Deposited the same amount of Iron on a like surface of another sheet.

This leaves 1/6 gram per sq. in.

Sept. 17.

Continue tests on Cell No. 2.

Charge over night at 25 ma. 900 min.

9.	1.94
9:5	1.87
9:10	1.84
9:35	1.78
9:45	1.77
10.	1.76
10:20	1.75
10:30	1.74
10:45	1.715
10:47	1.7
10:48	1.6
10:48'30"	1 Volt.

Input 2500 m.a.m.
Output 5425 "

285 m.a.m. per sq. in.

Open circuit voltage is 1.96

Charge	50 ma	60 min.
Dis "	50 "	45½ "

2:56	1.92
2:57	1.89
2:54	1.88
3	1.86
3:15	1.795
3:25	1.75
3:35	1.73
3:38	1.71
3:39	1.7
3:40	1.66
3:41	1.2
3:41'30"	1 Volt.

Input. 3000 m.a.m.

Output. 2275 "

Eff 77%

Charge	1.00	30 min.
Dis. "	50	46½"

5:10	1.92
5:15	1.86
5:25	1.81
5:35	1.78
5:45	1.75
5:50	1.725
5:55	1.7
5:55	1.62
5:56	1.3
5:56'30"	1 Volt.

Input 2000 m.a.m.
Output 2325 "

Eff 77½%

Sept. 17.

Continued tests on Cell No. 1.

Charge overnight at 25 ma 900 min.

Discharge 50 ma 178 min.

10:51	1.905
11	1.85
11:15	1.825
11:30	1.81
12	1.79
12:30	1.78
1	1.77
1:30	1.75
1:45	1.73
1:48	1.7
1:49	1 Volt.

Input 22500 m.a.m.

Output 8900 "

659 m.a.m. per sq. in.

Open circuit Voltage is 1.94

C105J

Charge	50 ma	60 min.
Dis. "	50 "	48 1/4"

3:45	1.87
3:50	1.83
4:10	1.78
4:25	1.74
4:30	1.72
4:33	1.68
4:33'15"	1 Volt.

Input. 3000 m.a.m.

Output. 24.12.5 "

Eff 80 1/2 %

Charge	100 mA	30 min.
Dis. "	50 "	47 "

5:57	1.88
6	1.85
6:15	1.83
6:30	1.76
6:40	1.73
6:43	1.7
6:44	1 Volt.

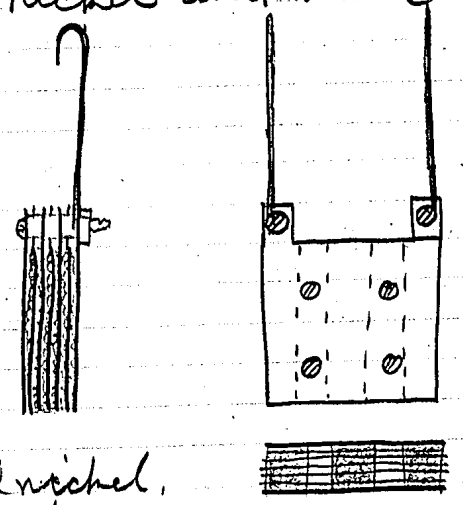
Input. 3000 mAm.

Output. 2350 "

78%

Sept. 17.

Constructed Cell No 3.
Nickel and Iron cell.



all nickel plates.

Spec. Ni(OH)2 is screened thru. #200 mesh.

Pos. 18 strips of (Rawlstone) paper, .004" thick, with deposit of Ni(OH)2 166 mg. per sq. in.
Area 13.5 sq in. (Pos.)

Neg. 18 strips same paper, deposit of iron 166 mg. sq. in.
all strips 3/8" x 2"
Area 13.5 sq in.

Quantity of Ni(OH)2 2.25 grams
" " iron 2.25 "

Sept. 18.

Cell No 1 Cont.

Charge	25 ma	60 min.
Dis. "	50 "	17 "
	1:28	1.88
	1:30	1.85
	1:35	1.815
	1:40	1.785
	1:45	1 Volt.

Input.	1500 m.a.m.	
Output.	850 "	56%

Charge	50 ma	60 min.
Dis. "	50 "	35½"
	3:17'30"	1.88
	3:45	1.78
	3:50	1.76
	3:53	1 Volt.

Input.	3000 m.a.m.
Output.	1775 m.a.m.
	62%

Note.
$Ni(OH)_2$ and the
Iron is screened
though #200 mesh screen

Charge	100 ma.	40 min.
Dis. "	50 "	52 "

4:38	1.93
5:5	1.815
5:20	1.77
5:25	1.755
5:29	1.7
5:30	1 Volt.

Input. 4000 m.a.m.

Output. 2600 "

.65%

Sept. 18.

Continued tests on Cell No. 2.

Charge	25 ma	60 min.
Dis. "	50 "	14 "

1.13	1.88
1.15	1.845
1.20	1.79
1.25	1.73
1.26	1.7
1.27	1 Volt.

Input. 1500 m.a.m.

Output. 700 "

46½ %

Charge	50 ma	60 min.
Dis. "	50 "	27 "

2.48	1.92
2.50	1.86
3.	1.8
3.10	1.74
3.13	1.68
3.15	1 Volt.

Input, 3000 m.a.m.

Output, 1350 "

45 %

Sept. 18.

Constructed Cell No. 4.
Nickel and iron.

Same plates construction as No 3. except that they are iron, nickel plated, .015" thick.

Spec.

Pos.
6 sheets of (Ravelstone) .004" thick.
166 mg. of Ni(OH)2 per sq. in.

Neg.
6 sheets of (Ravelstone) .004" thick.
166 mg. of iron per sq. in.

All sheets 1 1/16" x 2"

Area of Pos. plates 19 sq. in.
" " Neg. " 19 " "

(Area of 24, 1/4" holes is deducted from the above)

Quantity of Ni(OH)2 3 1/16 g.
" " iron 3 1/16 g.

Sept. 19.

Cell-No. 3. (test)
Charge overnight (Form) at
25 ma 960 min.
Discharge 50 " 172 "

9:30	1.61
9:32	1.54
9:35	1.4
9:40	1.38
9:45	1.37
10	1.35
10:30	1.33
11	1.32
11:30	1.305
12	1.295
12:15	1.285
12:20	1.275
12:22	1 Volt.

Input 24000 m.a.m.

Output 8600 "

active mat. 166 mg. per sq. in.
6.37 m.a.m. per sq. in.
10.6 m.a.h. " " "
.0106 a.h. " " "
Ampere hour capacity of cell .143

Sept. 19.

Constructed Cell No. 5.
Nickel and iron.

Spec.

Pos.
18 strips (Raveletone) .004" thick.
250 mg. $Ni(OH)_2$ sq. in.
Area 13.5 sq. in.

Neg.
18 strips (Raveletone) .004" thick
250 mg. Iron sq. in.
Area 13.5 sq. in.

Quan. of $Ni(OH)_2$ 4.5 g.
" " Iron. 4.5 g.

Note— Not screwed up very tight.

Sept 20.

Cell No 3. (test) cont.

Charge	50 ma	20 hrs.
Dis. "	50 "	262½ min.
	open circuit.	1.5
	8:47	1.475
	8:50	1.44
	9:5	1.38
	9:15	1.37
	9:30	1.36
	10	1.34
	10:30	1.33
	11	1.32
	11:30	1.315
	12:15	1.3
	12:30	1.295
	12:45	1.29
	1	1.28
	1:5	1.27
	1:9	1.23
	1:9' 30" fell rapidly.	1 Volt.

Input. 60000 M.A.M.
Output. 13100 "

970 M.A.M. per sq. in.
.016 A.H. " " "

[21]

Sept. 20.

Cell No-6.

Spec.—

Plate construction same as previously constructed cells.
(Nickel plated iron, .015" thick)

Pos.

6 sheets (Ravelstone paper) .004"
250 Mg. $Ni(OH)_2$ per sq. in.
Area. 19 sq. in.
Quantity of $Ni(OH)_2$ 4.75 g.

Neg.

6 sheets (Ravelstone)
333 Mg. Iron per sq. in.
Area 19 sq. in.
Quantity of iron 6.327 g.

Screwed up tight.

Sept 20

Cell No 4 (test 1)

Formed at	25 Mg.	450 min.
Discharged	50 "	16 min.

open circuit.	1.5
4	1.46
4:2	1.39
4:5	1.34
4:10	1.31
4:15	1.26
4:16	1 Volt.

Input 11250 Mg
Output 900 "

(Not formed yet)

(47 Mg sq. in)

Cell No.	Form of strip or sheet	Dimensions	Pos. element: No. of strips or sheets	Pos. element: Area of Pos. element	Pos. element: Quantity of Ni(OH)2	Pos. element: Ni(OH)2 sq. in.	Neg. element: No. of strips or sheets	Neg. element: Area	Neg. element: Quantity
1	strips	1/8"x2"	10	13.5 sq in	3½ g.	166			
2	sheets	1 1/16"x2"	6	19 sq in.					

Ions sq in	Milliamperes cap. sq in.	Amp. hour Cap.	Ampere Eff.	Watt Eff	Open Voltage

Sept 20.

Cell No 5. (test 1)

Formed at	25 MA	450 mins
Discharged	50 "	132½ "

open	1.52
4:20	1.5
4:21	1.47
4:23	1.45
4:25	1.43
4:30	1.42
4:45	1.38
5	1.36
5:15	1.345
5:30	1.335
5:45	1.325
6	1.315
6:15	1.31
6:30	1.29
6:31	1.28
6:32	1.26
6:32'10"	1 Volt.

Input. 11250 MAM.
6608 "
Output.
489 MA sq in.

[125]

Sept. 21.

Ce 22. No. 3 (test No. 3)

Charge	50 mA	20 hrs.
Dis. "	50 "	248 min.
	open	1.5
	9:5	1.47
	9:7	1.44
	9:10	1.42
	9:20	1.39
	9:30	1.375
	9:45	1.36
	10	1.34
	10:30	1.32
	11	1.31
	11:30	1.3
	11:45	1.295
	12	1.285
	12:15	1.28
	12:30	1.275
Input—	12:45	1.265
60 000 mam.	1	1.255
	1:5	1.25
Output—	1:10	1.24
12 400 m.a.m.	1:13	1.22
	1:13'30"	1.2
	1:13'40"	1 Volt.

911 m.a, sg in.

Sept. 21.

Cell No 4 (test 2)

Charged	25 ma	17 hrs.
Dis. "	50 "	31 min.

open	1,5
9:39	1,44
9:40	1,38
9:42	1,345
9:45	1,32
9:50	1,29
9:55	1.275
10	1,265
10:5	1,255
10:10	1,23
10:12	1 Volt.

Input. 25500 m.a.m.

Output. 1550 "

81 ma. rgin.

Sept 21.

Cell No 5. (test 2)

Charge	25 ma	16 hrs.
Dis. "	50 "	198 min.
	10:20	1.5
	10:21	1.48
	10:22	1.445
	10:28	1.4
	10:30	1.395
	10:45	1.36
	11	1.34
	11:30	1.315
	12	1.3
	12:15	1.295
	12:30	1.29
	12:45	1.28
	1	1.275
	1:15	1.265
	1:25	1.245
	1:26	1.23
	1:28	1 Volt.

Input — 24000 m.a.m.

Output. — 9400 "

696 m.a. sq in.

Sept 21.

Cell- No. 3. (test 4)

Charge	400 ma	30 min.
Dis. "	50 "	30 "
	open —	1.54
	2:26	1.52
	2:28	1.49
	2:30	1.46
	2:35	1.43
	2:45	1.4
	2:56	1.38

Stop 50 ma discharge, and raised to 1.7 ampere discharge.

	open	1.4
closed at 1.7 amps.	2:57	1.24
	2:57'15"	1.22
	2:57'30"	1.2
	2:57'45"	1.1
	2:58	1 Volt.

Gave cell rest for 1 minute.

	open	1.37
at 1.7 amps.		1.21
dropped in 5 seconds to		1.2

Drop in first case .16 Volts.
" " second " .17 end of 5th sec.

Sept. 22

Ce 22-770.6
Form at 25 ma
Discharge 50 ma

	3 hrs.
	130½ min.
open	1.51
8:30	1.5
8:32	1.46
8:35	1.43
8:45	1.38
9	1.355
9:30	1.325
10	1.31
10:15	1.3
10:30	1.285
10:48	1.26
10:40'30"	1 Volt.

Input — 45000 m.a.m.
Output. 6525 "

343 m.a. avg in.

Sept. 22.

Cell No 4. (test 3)

Charge	25 mA	24 hr.
Dis. "	50 "	79 2/3 min
open		1.495
10:55		1.45
10:57		1.4
11		1.375
11:5		1.35
11:15		1.33
12		1.295
12:14		1.26
12:14'30"		1.24
12:14'48"		1 Volt.

Input — 36000 mam.

Output — 3982 "

209 m.a. sq. in.

Sept 22

Cell No 5. (test 3)

Charge 25 ma 24 hrs.

Discharged at 1.7 Amperes.

open	1.5
at 1.7 Amps.	1.32

Voltage fell gradualy at the rate of .01 Volts each 5 seconds untill 1.2 was reached.

Remained at 1.2 for 5 min.

Fell to 1 Volt.

Initial drop is .18 Volts.

Sept 22

Ce 22-No 3. (Test 5)

Screw tightened up very tight.

Charge	50 M.A.		20 hrs.
Dis.	50 "		23 1/2 min.
	open		1.48
	1:46		1.45
	1:44		1.43
	2		1.395
	2:15	✓	1.375
	2:35	✓	1.35
	3	✓	1.33
	3:15	✓	1.32
	4	✓	1.285
	4:15	✓	1.275
	4:30	✓	1.255
	4:50	✓	1.215
	4:53	✓	1.195
	4:54	✓	1.175
	4:55	✓	1.145
	4:56	✓	1.13
	4:57	✓	1.12
	4:58	✓	1.105
	4:59	✓	1.1[illegible]
	5	✓	1.095
	5:1	✓	1.09
	5:2	✓	1.09
	5:5		1.085

5:10	1,085
5:15	1,085
5:25	1,08
5:30	1,075
5:35	1,065
5:40	1,06
5:45	1,045
5:47	1,02
5:47 '30"	1 Volt.

Input. 60000 M.A.M.

Output. 12075 M.A.M.

Tightening increases the resistance.

The output remains the same.

635 M.A. sq in.

Sept.

Cell No 7.

Same as cell No 4, except that it is not screwed up tight. (quite loose)

Pos.

6 sheets of (Ravelstone) .004"
166 mg. $Ni(OH)_2$ per sq. in.
Area. 19 sq. in.
Quantity of $Ni(OH)_2$ 3½ g.

Neg.

6 sheets of [illegible] paper.
166 mg. Iron.
Area. 19 sq. in.
Quantity of Iron 3½ g.

Sept. 23. 19

Cell No 6.

Charge	25 ma.	480 mins
Dis. "	50 "	68 "
open		1.476
	11:56	1.45
	12:2	1.36
	12:9	1.335
	12:16	1.315
	12:24	1.295
	12:56	1.26
	1:2	1.24
	1:3	1.2
	1:4	1 Volt.

Input.— 12000 m.a.m.

Output.— 3400 "

179 ma per sq in.

Sept. 23.

Cell-No. 4

Charge	25 M.a.	375 min.
Dis. "	50 "	26½"

open.	1.455
11:58	1.4
12:3	1.33
12:10	1.305
12:15	1.285
12:24'30"	1.26
12:25	1 Volt.

Something wrong with this cell.

Will realign the plates.

Input. — 9375

Output. — 1350.

71 Ma. sq. in.

Sept. 23

Cell — No. 5.

Charge	25 m.a.	300 min
Dis. "	50 "	250 "
	open	1.47
	12	1.435
	12:3	1.385
	12:15	1.375
	12:25	1.355
	12:55	1.32
	1:3	1.315
	1:10	1.31
	1:25	1.305
	1:53	1.295
	2:10	1.29
	2:15	1.285
	2:30	1.28
	3	1.275
(926 m.a. sq. in.)	4	1.25
	4:5	1.23
	4:7	1.2
	4:10	1 Volt.

Input. — 7500 m.a.m.

Output. — 12500 "

This cell has not been fully discharged from previous test.

Sept. 24.

Cell-No. 8

Pos.

18 strips white paper .003" thick
$\frac{3}{8}$" X 2"

83 1/3 M.G. $Ni(OH)_2$ sq in.

Area 13.5 sq. in.

Quantity of $Ni(OH)_2$ 1 1/8 grams.

Neg.

18 strips of same paper,

83 1/3 M.G. sq. in. (Iron)

Area 13.5 sq. in.

Quantity of Iron. 1 1/8 grams

Remarks.— Strips were laid on plates and squeezed on.
This is a good stunt as strip stick to plates and allow cells to be handled (screwed up fairly tight)

Sept. 24.

The proportion of the experimental cells to the cells required is about 100.

From this 1.5 Ampere discharge on experimental cells would be equivalent to 150 Amp. discharge of large cell.

Figuring on 10 Ampere charge in automobile (without lamps burning) this would be 100 M.A. charge rate for small cells.

Notes

.003" paper is very difficult to handle.

The .004" seems to be the best.

Sept 24.

Ce22-No. 3. (test 6)

Charge	50 ma	20 hrs.
Dis. "	50 "	23½ min
open		1.47
9		1.44
9:1		1.42
9:2		1.415
9:3		1.41
9:4		1.4
9:10		1.38
9:30		1.35
9:40		1.335
10		1.32
10:20		1.305
10:40		1.295
11		1.28
11:20		1.275
11:40		1.26
12		1.23
12:5		1.205
12:6		1.2
12:7		1.19
12:8		1.175
12:9		1.15
12:10		1.12
12:11		1.105
12:12		1.1

Cell-No.3.

12:13	1.095
12:14	1.09
12:15	1.09
12:20	1.085
12:30	1.08
12:40	1.075
12:50	1.065
12:55	1.06
12:57	1.05
12:59	1.03
12:59'30"	1 Volt.

Input.— 60000 MAM.
Output.— 11975 "

Sept 24.

Cell-No.4.

Charge	50 M.a.	20 hrs.
Dis.	50 "	99 min.

Realigned the plates in this model previous to this test.

open	1.42
1:1	1.38
1:2	1.36
1:3	1.355
1:10	1.33
1:20	1.32
1:30	1.305
1:40	1.3
2	1.29
2:20	1.275
2:30	1.265
2:40	1 Volt.

Input. — 60000 M.a.M.

Output. — 4950 "

Something wrong with this cell yet! —

Sept. 14.

Cell-No. 5.

Charged 50 MA 20 hrs.

Dis. " 50 " 325 min

	open	1.45
	2:10	1.42
	2:12	1.41
	2:15	1.4
	2:20	1.39
	2:30	1.37
	2:40	1.355
	2:50	1.345
	3:10	1.33
	3:30	1.32
	3:50	1.31
	4:10	1.3
	4:30	1.295
	5:10	1.29
	5:40	1.28
Input.	6	1.275
60000 M.A.M.	6:20	1.27
	6:40	1.26
Output.	7	1.25
	7:20	1.24
16250 M.A.M.	7:30	1.23
	7:35	1 Volt.

Sept. 24.

Cell-No. 6.

Charge	50 ma.	20 hrs.
Dis. "	50 "	24 6 min.
	open	1.5
	10	1.48
	10:1	1.46
	10:2	1.44
	10:4	1.42
	10:5	1.415
	10:10	1.4
	10:20	1.37
	10:40	1.345
	11	1.33
	11:20	1.32
	11:40	1.31
	12	1.3
	12:40	1.295
	1	1.285
	1:20	1.28
	1:40	1.27
	2	1.245
	2:5	1.24
	2:6	1 Volt.

Input. 60000 m.a.m.

Output. 12300 m.a.m.

(1[illegible])

Cell-No.7 Sept. 24.

Charge	50 MA	20 hrs.
Dis. "	50 "	115 min
	open	1.4
	2:42	1.37
	2:43	1.36
	2:44	1.355
	2:50	1.34
	3:10	1.32
	3:30	1.31
	3:50	1.3
	4:10	1.295
	4:30	1.28
	4:35	1.26
	4:37	1 Volt.

Input — 60000 M.A.M.

Output — 5750 "

Not yet Formed fully.

Sept. 25.

Cell-No. 3.

Charge 25 M.A. 12 hrs.
" 100 " 60 mins
Discharge 1.7 amps.

open 1.52
at 1.7 amps. 1.3
1.2
Readings taken at 1.04
10 second intervals. 1
.82

Rest for two min.

open 1.27
closed 1.04
10 sec. .98

Recharge 50 MA 5 min.
open 1.36
at 1.7 amps. 1.2
1.06
10 second intervals. .096
.092
.09

[165]

Recharge 50 M.A. 10 min.

open 1.395
1.7 Amp. 1.24
1.1
1.
.96
.93

Charge 200 M.A. 60 min.
Dis. " 1.5 Amps.

open 1.525
1.5 Amps. 1.32
1.24
10 second intervals. 1.06
.99

Rest of 1 min.
open 1.32
1.5 Amps. 1.2
.94

Rest of 3 min.
open 1.32

Charge 100 MA	5 min.
open	1.465
1.5 Amps.	1.32
10 second intervals.	1.22
	1.8
Rest of 1 min.	
open.	1.39
1.5 Amps.	1.26
	1.16
	1
Rest of 1 min.	
open	1.33
1.5 Amps	1.2
	.92
Charge 100 MA	5 min.
open	1.355
1.5 Amps.	1.2
	1.02
	.96

Cell-No. 4.

Charge 25 MA 12 hrs.
" 100 " 60 min

Discharge at 1.5 Amps.

1.5 A. open 1.415
1.2
.9

Rest of 1 min.

1.5 A. open 1.38
1.14

10 second intervals.

Ce22-No.5.

Charge 25 ma. 12 hrs.
and " 100 " 60 min.
Discharge 1.5 amps.
open. 1.46
1.5a. 1.3
1.27
10 second intervals 1.24
1.23
1.215
1.2
1.195

Rest 1 min.
open 1.34
1.5a. 1.22
1.2
1.19
1.18
1.17

Charge 50 ma 5 min.
open 1.46
1.5a 1.24
1.2
10 second intervals. 1.18
1.175

1.17
1.16
1.6
1.55
1.5
1.4
1.4

Rest 1 min.

1.5 a. 1 pm

1.35
1.18
1.145
1.13
1.2
1.1
0

Fairly good

1.18 4
~~4.9 oz~~

Charge 200 ma. 60 min.
Dis. " 1.5 amps.

1.5 a. open

1.555
1.4
1.32
1.295
1.27
1.26
1.25
1.24
1.23
1.255
1.22
1.215
1.21
1.25
1.2
1.195
1.195
1.19
1.185
1.18
1.18
1.18
1.175
1.175

1.16
4
4.64

10 second Intervals.

1.17
1.17
1.16
1.16
1.16
1.15
1.145
1.14
1.135
1.125
1 Volt.

Rest for 1 Min.
open
1.5 a.

1.34
1.16
1.14
1.

Charge 100 MA 5 min.
open.

1.42
1.22
1.14
1.14
1.

Very good

Cell—No. 6.

Charge 25 M.a. 12 hrs.
" 100 " 60 min.
Dis. " 1.5 amps.

open 1.45
1.5 a. 1.3
1.24
1.22
10 second Intervals. 1.2
1.19
1.18
1.17

Rest of 1 min.
open 1.375
1.5 a 1.2
1.17
1.16
1.14
1.1

Rest 1 min.
open 1.36
1.5 a. 1.16
1.12
0

Charge 50 ma	5 min.
open	1.43
1.5 a.	1.3
	1.1
Rest 1 min.	
open	1.36
1.5 a.	1.12

Cell—No. 7.

Charge	25 m.a.	12 hrs.
"	100 "	60 min.
Dis. "	1.5 amps.	
open		1.42
1.5a		1.22
		1.14
10 second intervals.		1.07
		.96
Rest 1 min.		
open		1.37
1.5a		1.18
		1.06
Charge 50 ma		5 min.
open		1.445
1.5a.		1.2
		1.12
Rest 1 min.		
open		1.36
1.5a		1.14

Ce22—No.8

Charge	25 M.A.	12 hrs.
~~Dis~~ "	100 "	60 min.
Dis. "	1.5 amps.	
open		1.39
1.5 a.		1.2

Not yet formed.

Note. The 25 M.A. and 100 M.A. charges on the foregoing tests is not accurate, as the rheostats have been tampered with during the night.

The 200 M.A. charge on the respective cells for 1 hour is accurate.

The resulting voltage drop datta is also accurate for this charge.

Sept. 25.

Datta on Ford generator.

Current.		Voltage.		Miles per hour.
1		7	7	10
3				12
6		7.5	18	15
9				18
11	charge	8	open 30	20
12.5	Volts.			23
13		8.2	40	25
13.5		8.4	45	30
			50	35

Max. current when engine is racing is 15 Amps.

Relay cut out is at 7 Volts. which is at 10 M.P.H.

Lamp consumption is.
Dim — 1.3
bright. — 5.1

Battery Voltage idle is 6.8 V

.8 Volt drop when motor is in circuit. 3 seconds.

Slow recovery.

Sept. 23.

Data on a 20 A.H. cell

Figuring on 970 m.a.m. per sq. in which is the best results obtained to the above date, with cell No. 3,

No. of Pos. plates reqd.	20	5"X6"
" " Neg " "	20	5X6"

total area of Pos.	1200 sq. in.
" " " Neg	1200 " "

Quan. of $Ni(OH)_2$	199 g.	8 oz.
" " Iron.	199 g.	8 oz.

weight of 40, 4"X5" plates .007" thick	1.56 lbs.	24.93
" " 2 " " .0625" "	.7 lbs.	11.20

Approx. dimensions of cell assembled using paper .004 thick.
5X7X1 1/4"

Approx. weight of electrolyte	12 oz.
" " " can	55 lb. 8.8 oz.
" " " paper	4 oz

Approx weight of one complete cell in can without box 5 lbs.
Approx weight of elements without can and electrolyte 3 1/2 lbs.

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Continued in Book 2.

13,5 / 13,000 | 970
12,5
150
94,5
50

13,5 / 162500 | 1204
135
275
270
500

19 / 4950
36
135
133
20

27 / 13,5 / 48000 | 355
405
750
675
750

19 / 14850 | 781
133
155
152
30

60 / 8,900 | .148
60
290
240
500
480

19 / 12900 | 679
114
150
133
170
171

60 / 5,425 | .0904
540
250

17,54 / 950000 | 540
8790
7100
7032
680

.0904
09,040

60 / 13,100 | .218
120
100
60
500